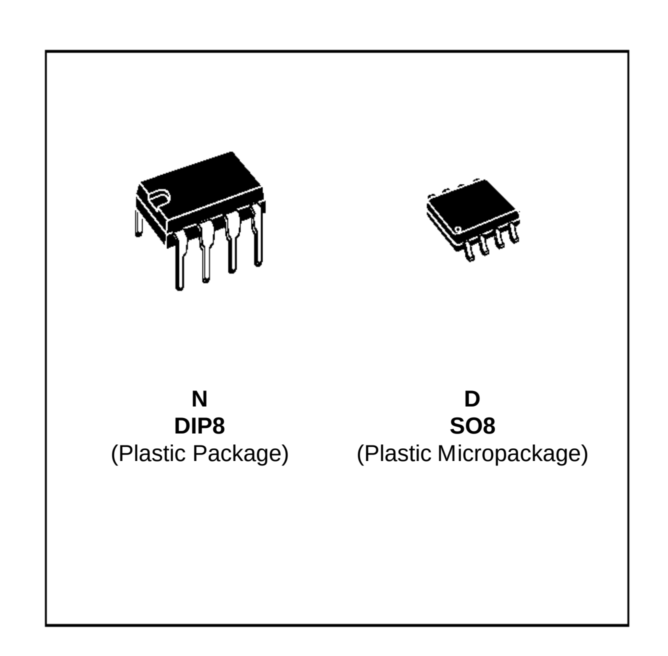


TS912

INPUT/OUTPUT **RAIL TO RAIL** DUAL CMOS OPERATIONAL AMPLIFIER

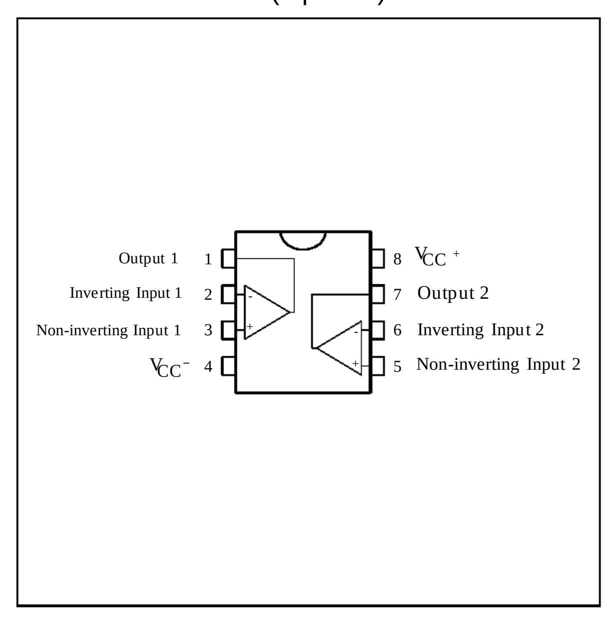
- **RAIL TO RAIL** INPUT AND OUTPUT VOLTAGE RANGES
- SINGLE (OR DUAL) SUPPLY OPERATION FROM **2.7V TO 16V** (±1.35V to ±8V)
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA** TYP
- LOW INPUT OFFSET VOLTAGE : **2mV max.**
- SPECIFIED FOR **600Ω** AND **100Ω** LOADS
- LOW SUPPLY CURRENT : 400µA/Ampli
- SPEED : 1.4MHz - 1.3V/µs
- ESD TOLERANCE : 3KV
- LATCH-UP IMMUNITY
- **SPICE MACROMODEL** INCLUDED IN THIS SPECIFICATION



ORDER CODES

Part Number	Temperature Range	Package	
		N	D
TS912I/AI/BI	-40, +125°C	•	•

PIN CONNECTIONS (top view)



DESCRIPTION

The TS912 is a RAIL TO RAIL dual CMOS operational amplifier designed to operate with single or dual supply voltage.

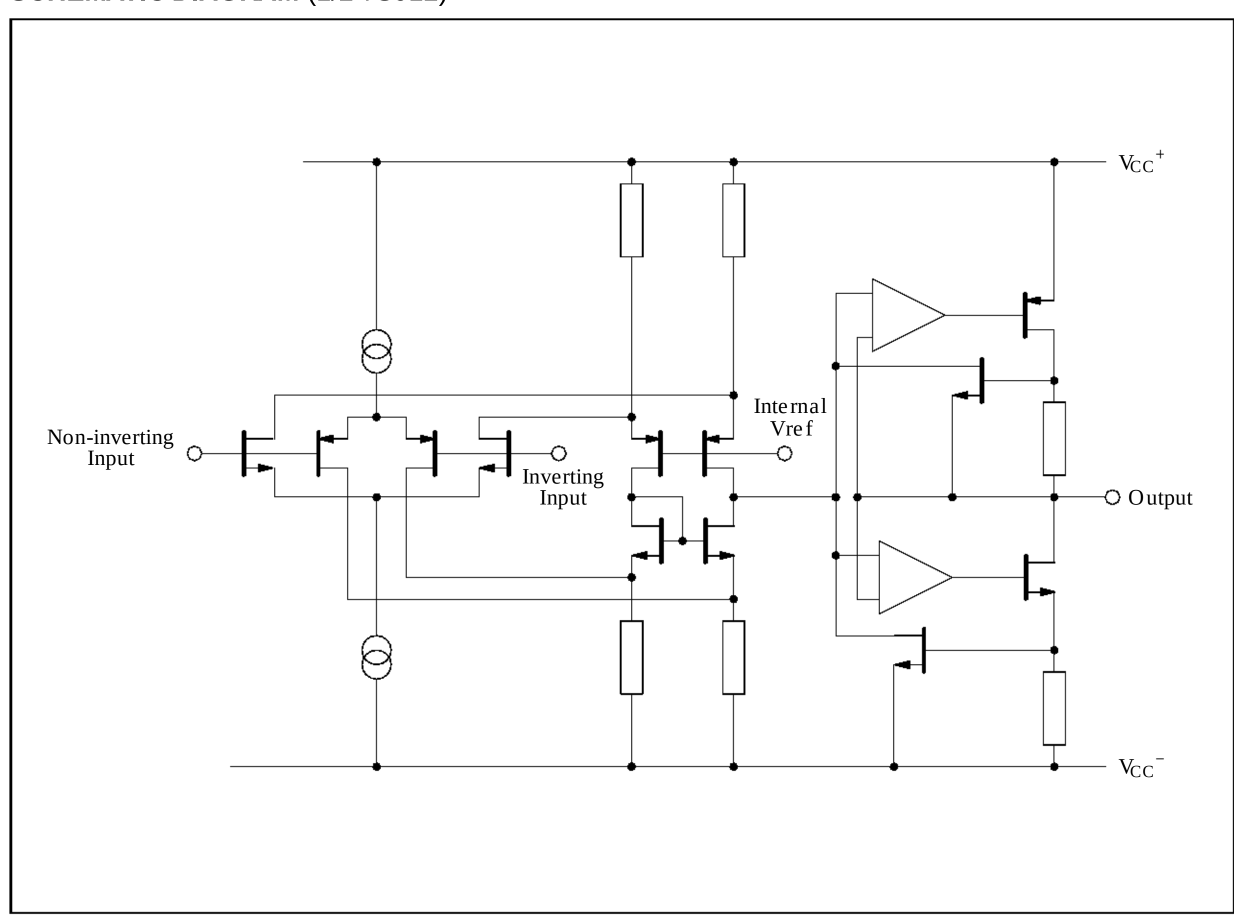
The input voltage range V_{icm} includes the two supply rails V_{CC}^+ and V_{CC}^-.

The output reaches :

- V_{CC}^- +50mV V_{CC}^+ -50mV with R_L = 10kΩ
- V_{CC}^- +650mV V_{CC}^+ -650mV with R_L = 600Ω

This product offers a broad supply voltage operating range from 2.7V to 16V, a supply current of only 400µA/amp (V_{CC} = 10V) and a high output current capability fixed by an internal limitation circuit : I_{source} = 65mA - I_{sink} = 75mA

SCHEMATIC DIAGRAM (1/2 TS912)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage - (note 1)	18	V
V_{id}	Differential Input Voltage - (note 2)	±18	V
V_i	Input Voltage - (note 3)	-0.3 to 18	V
I_{in}	Current on Inputs	±50	mA
I_o	Current on Outputs	±130	mA
T_{oper}	Operating Free Air Temperature Range TS912I/AI/BI	-40 to +125	^oC
T_{stg}	Storage Temperature	-65 to +150	^oC

Notes : 1. All voltage values, except differential voltage are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. The magnitude of input and output voltages must never exceed V_{CC}^+ +0.3V.

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	2.7 to 16	V
V_{icm}	Common Mode Input Voltage Range	V_{CC}^- -0.2 to V_{CC}^++0.2	V



ELECTRICAL CHARACTERISTICS

V_{CC}^+ = 10V, V_{CC}^- = 0V, R_L,C_L connected to $V_{CC}/2$, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter		TS912I/AI/BI			Unit
			Min.	Typ.	Max.	
V_{io}	Input Offset Voltage ($V_{ic} = V_o = V_{CC}/2$) $T_{min.} \leq T_{amb} \leq T_{max.}$	TS912 TS912A TS912B TS912 TS912A TS912B			10 5 2 12 7 3	mV
DV_{io}	Input Offset Voltage Drift			5		µV/°C
I_{io}	Input Offset Current - (note 1) $T_{min.} \leq T_{amb} \leq T_{max.}$			1	100 200	pA
I_{ib}	Input Bias Current - (note 1) $T_{min.} \leq T_{amb} \leq T_{max.}$			1	150 300	pA
I_{CC}	Supply Current (per amplifier, A_{VCL} = 1, no load) $T_{min.} \leq T_{amb} \leq T_{max.}$			400	600 700	µA
CMR	Common Mode Rejection Ratio	V_{ic} = 3 to 7V, V_o = 5V V_{ic} = 0 to 10V, V_o = 5V	60 50	90 75		dB
SVR	Supply Voltage Rejection Ratio (V_{CC}^+ = 5 to 10V, $V_O = V_{CC}/2$)		60	90		dB
A_{vd}	Large Signal Voltage Gain (R_L = 10kΩ, V_O = 2.5V to 7.5V) $T_{min.} \leq T_{amb} \leq T_{max.}$		20 15	60		V/mV
V_{OH}	High Level Output Voltage (V_{id} = 1V) $T_{min.} \leq T_{amb} \leq T_{max.}$	R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω R_L = 10kΩ R_L = 600Ω	9.95 9.85 9 9.8 8.8	 9.95 9.35 7.8		V
V_{OL}	Low Level Output Voltage (V_{id} = -1V) $T_{min.} \leq T_{amb} \leq T_{max.}$	R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω R_L = 10kΩ R_L = 600Ω		 50 650 2300	50 150 800 150 900	mV
I_o	Output Short Circuit Current (V_{id} = ±1V)	Source ($V_o = V_{CC}^-$) Sink ($V_o = V_{CC}^+$)	45 50	65 75		mA
GBP	Gain Bandwidth Product (A_{VCL} = 100, R_L = 10kΩ, C_L = 100pF, f = 100kHz)			1.4		MHz
SR^+	Slew Rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 2.5V to 7.5V)			1.3		V/µs
SR^-	Slew Rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 2.5V to 7.5V)			0.8		V/µs
∅m	Phase Margin			40		Degrees
e_n	Equivalent Input Noise Voltage (R_s = 100Ω, f = 1kHz)			30		$\frac{nV}{\sqrt{Hz}}$
THD	Total Harmonic Distortion (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_O = 4.75V to 5.25V, f = 1kHz)			0.024		%
C_{in}	Input Capacitance			1.5		pF
V_{O1}/V_{O2}	Channel Separation (f = 1kHz)			120		dB

Note 1 : Maximum values including unavoidable inaccuracies of the industrial test.

TYPICAL CHARACTERISTICS

Figure 1 : Supply Current (each amplifier) versus Supply Voltage

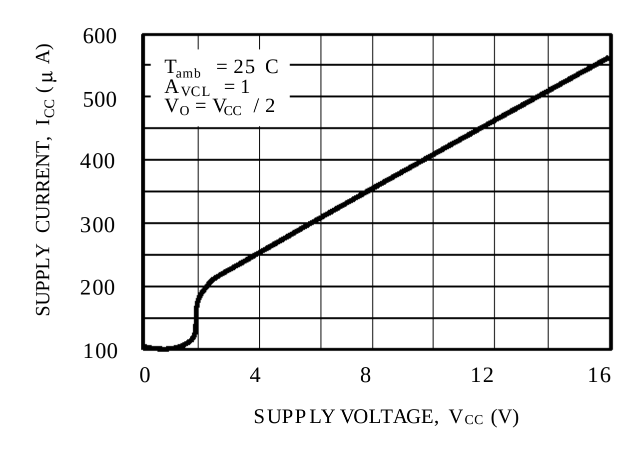


Figure 2 : Input Bias Current versus Temperature

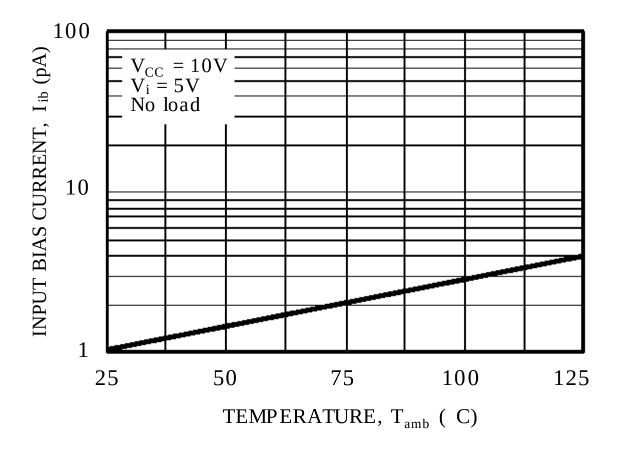


Figure 3a : High Level Output Voltage versus High Level Output Current

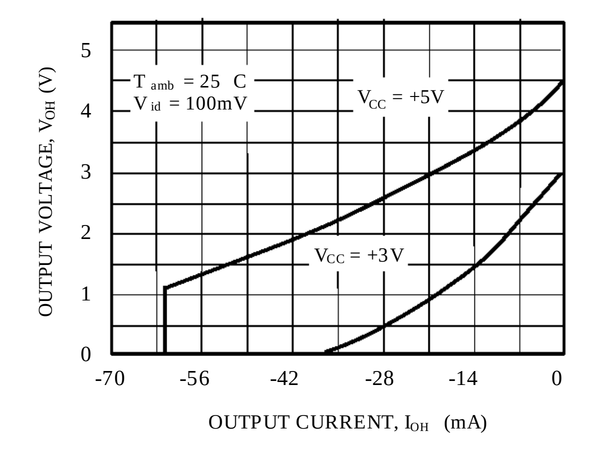


Figure 3b : High Level Output Voltage versus High Level Output Current

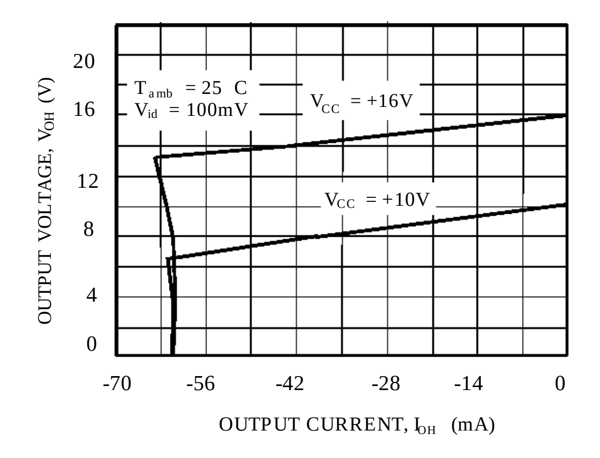


Figure 4a : Low Level Output Voltage versus Low Level Output Current

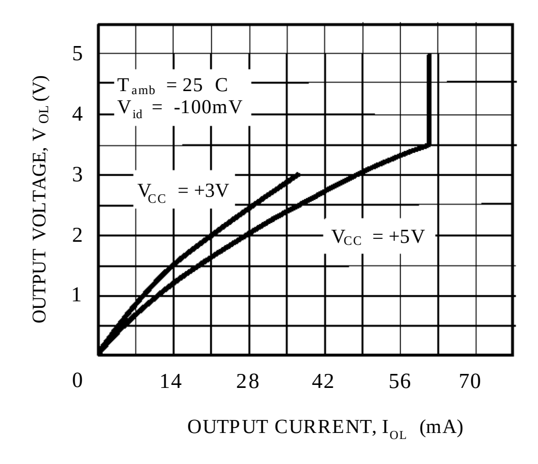


Figure 4b : Low Level Output Voltage versus Low Level Output Current

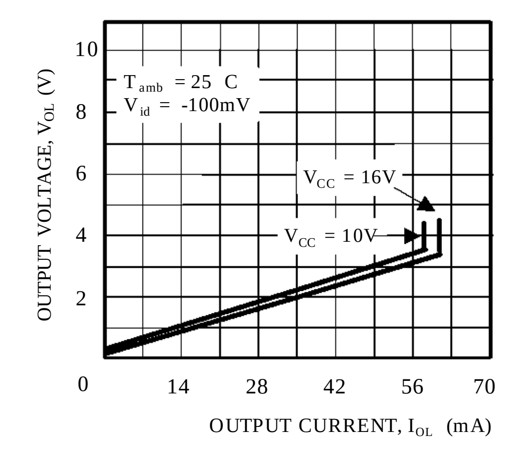


Figure 5a : Open Loop Frequency Response and Phase Shift

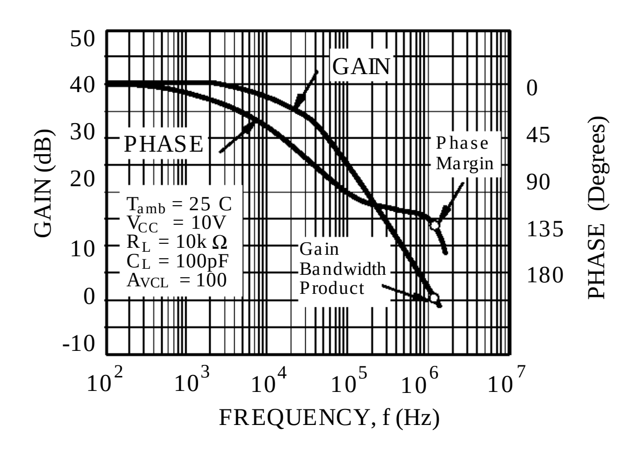


Figure 5b : Open Loop Frequency Response and Phase Shift

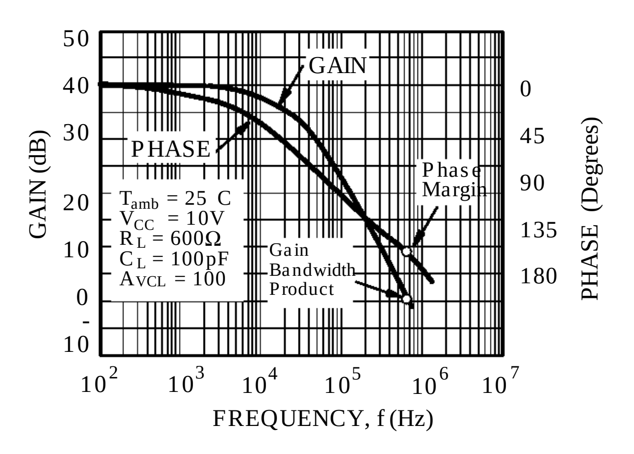


Figure 6a : Gain Bandwidth Product versus Supply Voltage

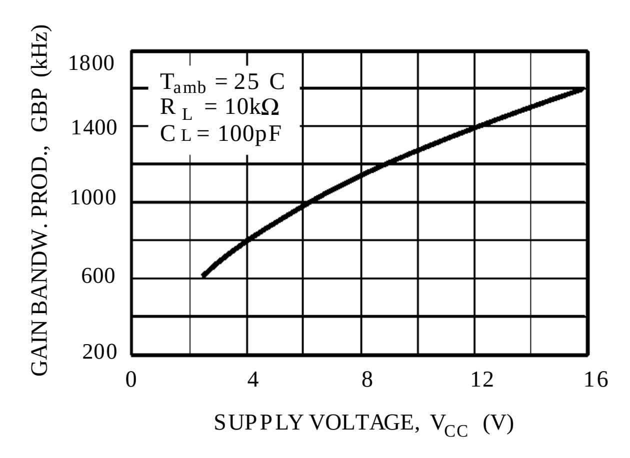


Figure 6b : Gain bandwidth Product versus Supply Voltage

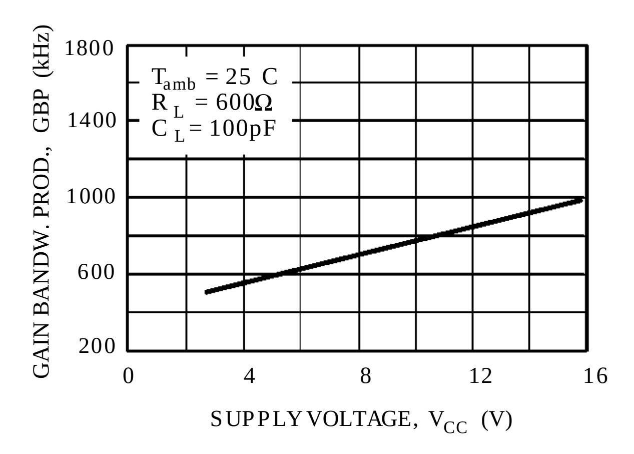


Figure 7a : Phase Margin versus Supply Voltage

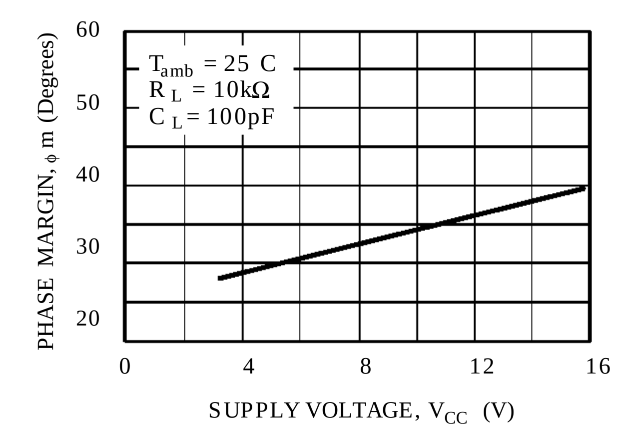


Figure 7b : Phase Margin versus Supply Voltage

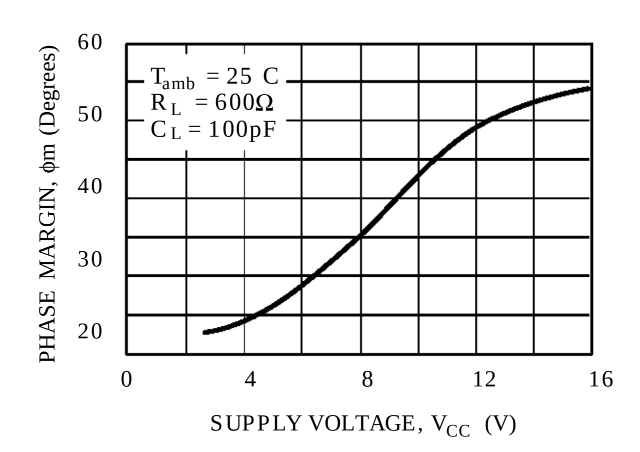
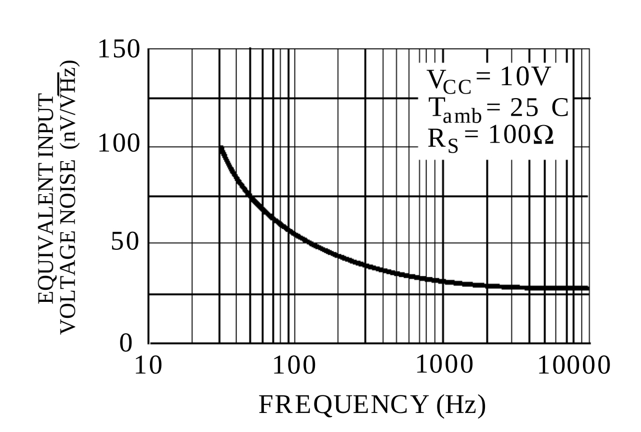
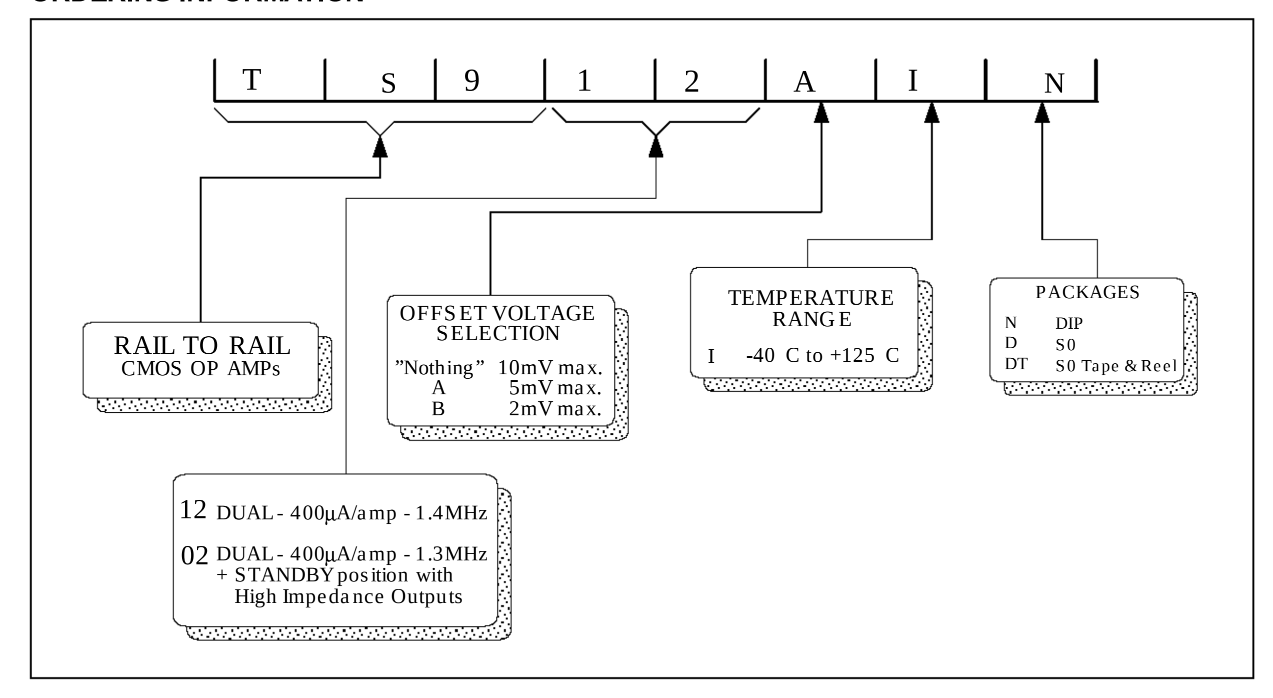


Figure 8 : Input Voltage Noise versus Frequency



ORDERING INFORMATION



MACROMODEL

- **RAIL TO RAIL** INPUT AND OUTPUT VOLTAGE RANGES
- SINGLE (OR DUAL) SUPPLY OPERATION FROM **2.7V TO 16V** (±1.35V to ±8V)
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA typ.**
- LOW INPUT OFFSET VOLTAGE : **2mV max.**
- SPECIFIED FOR **600**Ω AND **100**Ω LOADS
- LOW SUPPLY CURRENT : 400µA/Ampli
- SPEED : 1.4MHz - 1.3V/µs

Applies to : TS912I,AI

```
** Standard Linear Ics Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY

.SUBCKT TS912 1 3 2 4 5 (analog)
**********************************************************
.MODEL MDTH D IS=1E-8 KF=6.563355E-14 CJO=10F
* INPUT STAGE
CIP 2 5 1.500000E-12
CIN 1 5 1.500000E-12
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 6.500000E+00
RIN 15 16 6.500000E+00
RIS 11 15 7.655100E+00
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 0.000000E+00
VOFN 13 14 DC 0
IPOL 13 5 4.000000E-05
CPS 11 15 3.82E-08
DINN 17 13 MDTH 400E-12
VIN 17 5 -0.5000000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 -0.5000000E+00
FCP 4 5 VOFP 7.750000E+00
FCN 5 4 VOFN 7.750000E+00
* AMPLIFYING STAGE
FIP 5 19 VOFP 5.500000E+02
FIN 5 19 VOFN 5.500000E+02
RG1 19 5 5.087344E+05
RG2 19 4 5.087344E+05
CC 19 29 2.200000E-08
HZTP 30 29 VOFP 12.33E+02
HZTN 5 30 VOFN 12.33E+02
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 3135
VIPM 28 4 150
HONM 21 27 VOUT 3135
VINM 5 27 150
EOUT 26 23 19 5 1
VOUT 23 5 0
ROUT 26 3 65
COUT 3 5 1.000000E-12
DOP 19 68 MDTH 400E-12
VOP 4 25 1.924
HSCP 68 25 VSCP1 1E8
DON 69 19 MDTH 400E-12
VON 24 5 2.4419107
HSCN 24 69 VSCN1 1.5E8
VSCTHP 60 61 0.1375
DSCP1 61 63 MDTH 400E-12
VSCP1 63 64 0
ISCP 64 0 1.000000E-8
DSCP2 0 64 MDTH 400E-12
DSCN2 0 74 MDTH 400E-12
ISCN 74 0 1.000000E-8
VSCN1 73 74 0
DSCN1 71 73 MDTH 400E-12
VSCTHN 71 70 -0.75
ESCP 60 0 2 1 500
ESCN 70 0 2 1 -2000
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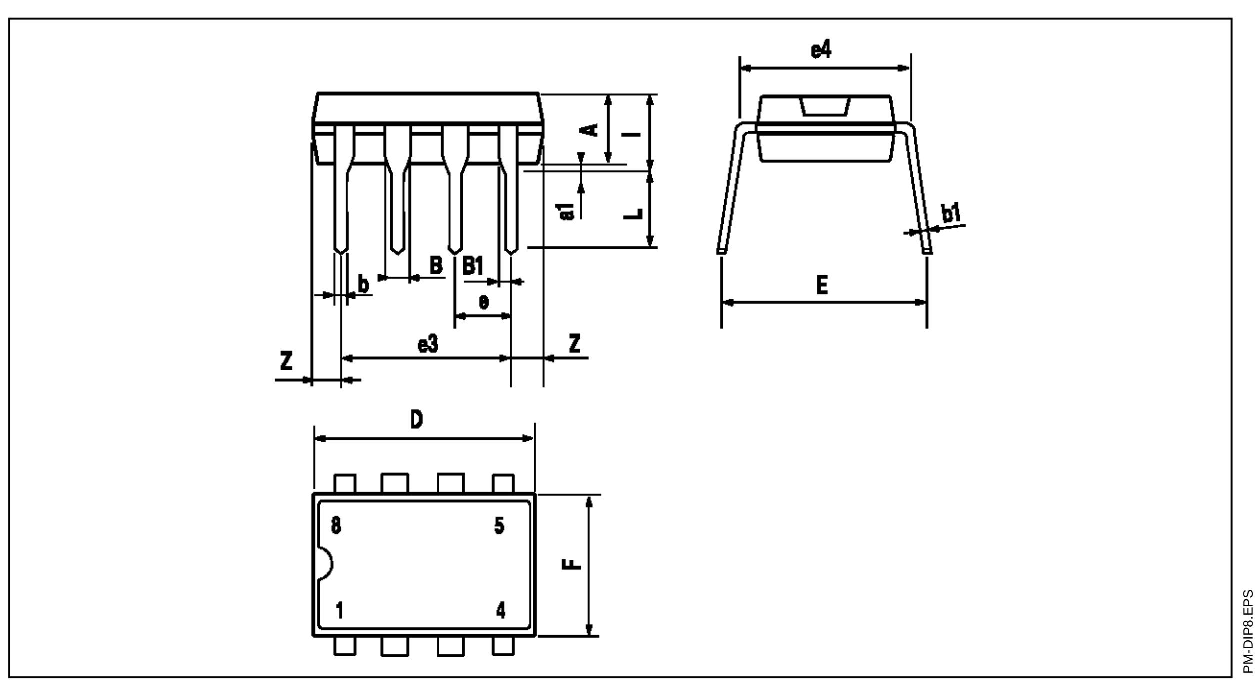
ELECTRICAL CHARACTERISTICS

V_{CC}^{+} = 10V, V_{CC}^{-} = 0V, R_L,C_L connected to $V_{CC}/2$, T_{amb} = 25°C
(unless otherwise specified)

Symbol	Conditions	Value	Unit
V_{io}		0	mV
A_{vd}	R_L = 10kΩ	20	V/mV
I_{CC}	No load, per operator	350	μA
V_{icm}		-0.2 to 10.2	V
V_{OH}	R_L = 10kΩ	9.95	V
V_{OL}	R_L = 10kΩ	50	mV
I_{sink}	V_O = 10V	50	mA
I_{source}	V_O = 0V	50	mA
GBP	R_L = 10kΩ, C_L = 100pF	1	MHz
SR	R_L = 10kΩ, C_L = 100pF	1	V/μs
∅m	R_L = 10kΩ, C_L = 100pF	40	Degrees

PACKAGE MECHANICAL DATA

8 PINS - PLASTIC DIP

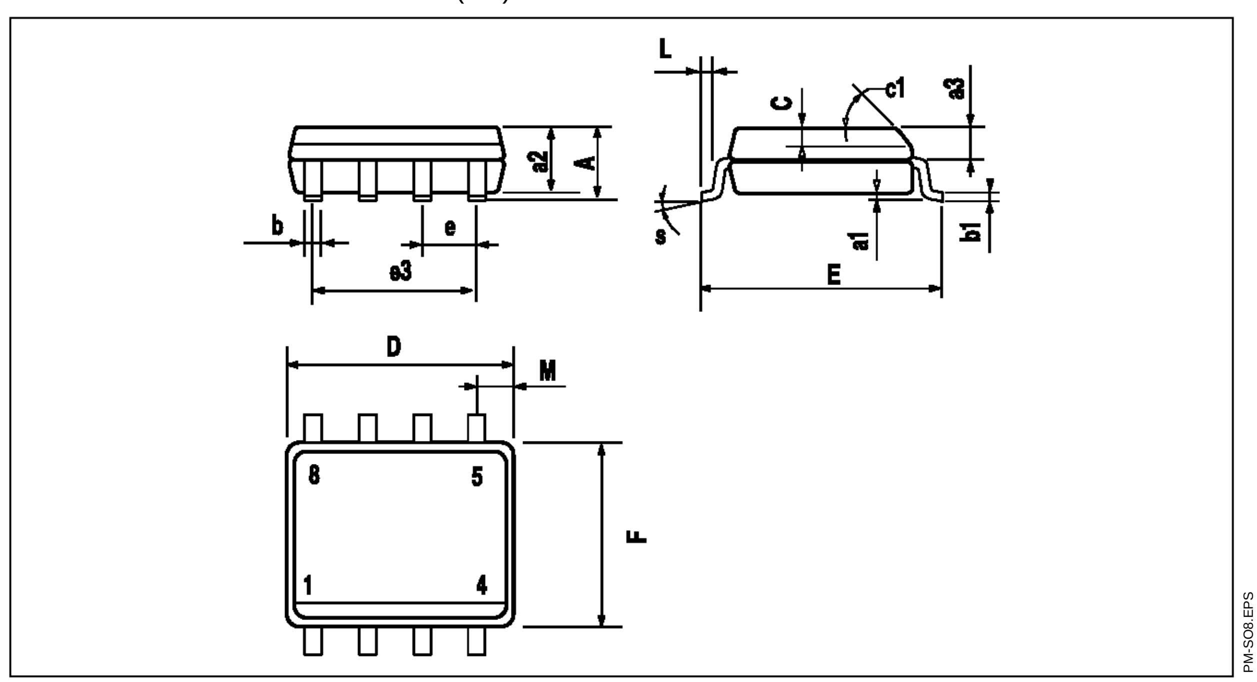


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

DIP8.TBL

PACKAGE MECHANICAL DATA

8 PINS - PLASTIC MICROPACKAGE (SO)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45^{o} (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8^{o} (max.)					

S08.TBL

ORDER CODE :